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LUNAR LESSONS.

BY RICHARD A. PROCTOR.

THE more the moon is studied, the clearer seems to be the evidence that she gives respecting the life history of a planet. She tells us more, perhaps, of the future of our earth than of the past; but she tells us of the past too. That the moon is waterless and practically airless too, now, is certain, and, therefore, there is probably no life now on her surface, though for those who like such fancies the belief is always open that there may be creatures on the moon utterly unlike any with which we are acquainted on earth. Yet the moon's face tells us of a remote youth—a time of fiery activity, when volcanic action even more effective (though not probably more energetic) than any which has ever taken place on this globe, upheaved the moon's crust. But so soon as we consider carefully the features of her surface we see that there must have been three well marked eras of vulcanian activity. Look at the multitudinous craters, for example, around the Metropolitan Crater (as Webb has happily named it) Tycho. They tell us of century after century of volcanic disturbance—but they tell us more. They mark a surface which varies in texture, and therefore in light-reflecting power in such a way as to show that the variations were produced long before the volcanic action began by which the craters were formed. For the variations of texture are such as to mark a series of streaks—some of them two or three thousand miles in length, and many miles in breadth, extending radially from Tycho. Craters lie indifferently on these brighter streaks and on the intervening darker spaces, and some craters can be seen which lie right across a bright streak with parts of their ring on the darker regions on both sides of the streak. Of course, this proves that the craters were formed long after the great streaks. When the streaked surface was formed, it must have been tolerably smooth; for we see the streaks best under a full illumination, and there is no sign of any difference of elevation between them and the darker ground all around; they are neither long ridges nor long valleys, but mere surface markings. Yet must they have been formed by mighty vulcanian disturbance, such, indeed, as we may be certain went on at the early stage of the moon's history, to which these radiating streaks must be referred. It seems clear that, as Nasmith has illustrated by experiment, they belong to that stage of the moon's history when her still hot and plastic crust parted with its heat more rapidly than the nucleus of the planet, and so, contracting more quickly, was rent by the resistance of the internal matter, which, still hot and molten, flowed into the rents, and spreading formed the long broad streaks of brighter surface. It seems as clear that the next stage of the moon's history (after many thousands, perhaps millions, of years had passed) was one in which the cooled crust, still plastic, contracted little, while the still hot nucleus contracted steadily, so shrinking from the crust, which, under the action of gravity, closed in upon the nucleus in such sort as to a form a wrinkled or corrugated surface. This was the second era of lunar vulcanian disturbance. The third was the era of great volcanic eruptions, during which the mighty craters were formed which are so numerous on the lighter tinted higher regions of the moon's surface. Were there no seas or oceans on the moon at this time? It is strange if there were none, when we consider the connection which exists on the earth between the activity of the great volcanic vents and the proximity of water. It is stranger still if we consider that those regions where, if water had ever existed on the moon, it would have formed seas, are without exception characterised by a different tint, and a different surface contour, from what we find in the regions which would in that case have formed the lunar continents. All the lower levels are dark, are much more uniform, and are marked by few craters, and those small. This is no mere accident or coincidence. It is a feature which we are justified in regarding as characteristic; and, so regarded, it seems to force upon us the conclusion that those lower levels are in reality old sea-floors, formed in a different way from the higher levels, and therefore presenting a different tint and reflecting a different amount of light.

When we thus recognise in the moon the three stages of past vulcanian energy which Mallet and Dana have recognised (though the evidence has not been quite so obvious) on the earth, and the signs also of a past fitness for the support of life, seeing that the presence of seas implies also the presence of an atmosphere dense enough to make the boiling-point of water not too low, we recognise the significance of the evidence which the moon gives respecting the earth's future. What has happened to her will happen also to our earth, though doubtless with variations in details corresponding to different conditions.

Yet science has good reason for regarding as exceedingly remote the time when the earth will be at the stage of planetary development which the moon has reached. If the earth's crust, God's work, whose teachings, therefore, if we can but read them aright, are God's words, speaks truly, it is certain that tens of millions of years have passed since even that stage of the earth's life through which she is now passing began. But suppose, for the sake of argument, we put twelve million years only as the time which has elapsed since the earth and moon were at the same (necessarily much earlier) stage of planetary life. The earth's mass exceeds the moon's 81 times, and therefore at that time she had 81 times as much heat to part with as the moon. But her surface is now (and the proportion cannot have been very different then) only some $13\frac{1}{2}$ times greater than the moon's. Thus, since 81 contains $13\frac{1}{2}$ six times, the earth has parted with her heat at only one-sixth of the rate which would have made the supply last just as long as the moon's. Each stage of the earth's cooling, or of the earth's life, has been six times as

long as the corresponding stage of the moon's, and the 12 million years of earth history correspond to about two million years of moon life. Ten million years ago, then, the moon was in the same stage of planetary life that the earth is now passing through. But those ten millions of years of moon-life correspond to sixty millions of years of earth-life. Wherefore, on the very moderate assumption I have made as to the time which has elapsed since earth and moon were both young, sixty millions of years would have to elapse before the earth would have reached the stage of life through which the moon is now passing.—*Newcastle Weekly Chronicle.*

A NATURALIST'S YEAR.

By Grant Allen.

XIV.—AMONG THE GRASSES.

THE meadows are now all out in full blossom, and the various sedges, grasses, and plantains, which make up the larger part of their greensward, are at this moment in the busiest epoch of their existence, universally engaged in getting themselves fertilised by the friendly intervention of the unconscious wind. Pick any one of them that you choose for examination, and you will find that, widely as these meadow plants differ from one another in origin and in underlying botanical structure, they are all closely similar in external and adaptive characteristics. By the very necessity of the situation they are almost universally wind-fertilised, and they have undergone a certain number of modifications in a single direction, in order to fit them for this particular niche in Nature. Insect-fertilised plants may have their flowers buried among the foliage or pressed close to the ground, provided only they are conspicuous enough to attract the eyes of passing insects; but wind-fertilised blossoms must raise their heads high above the neighbouring foliage, so as to have free access to the breezes of heaven; and so all these grasses, sedges, and plantains have tall tufted flowers usually hanging loose in graceful, plume-like panicles, so as to be easily moved by every gentle breath of wind. Then, again, the stamens themselves hang far out of the enclosing scales or glumes, on long thread-like filaments, and quiver like aspen leaves before the faintest flutter of the air, so as to shed their pollen readily and instantaneously, wherever the wind is ready to carry it. Finally, the stigmas, or sensitive surfaces of the ovary, also protrude bodily from their coverings, and are split up into innumerable little feathery branches, so as to catch whatever pollen may chance to be wafted their way. If you look closely at the surface of a meadow waving in the wind, you will see that it is all one mass of tiny purple bloom, shivering tremulously before the breeze, and scattering little showers of light pollen with every movement of the pendulous heads and stems.

Of course, plants of such a sort can only succeed under a combination of two diverse conditions. In the first place, they must grow in open, unimpeded places, where the breeze can get at them freely, and the pollen can be carried before it without let or hindrance. In the second place they must grow together in large masses—must be gregarious in habit—or else the pollen would most probably get wasted in traversing the distance between one plant of the species and another. Among all the herbs which have adapted themselves to this peculiar conjunction of circumstances there are none more successful than the grasses. Indeed, most careless observers imagine that the sward of a meadow or pasture is almost entirely made up of grasses; and though this is very far from being the case (for at least one-half the plants in it are larger-leaved species, such as clovers, sorrels, and buttercups) yet the grasses certainly occur in such large numbers, and so overtop the other weeds around them, as to give the general character and tone to the low-land flora of temperate countries like our own England. If we glance for a moment at their constitution and nature, we shall be getting an insight into one of the most dominant plant families in the whole creation.

The simplest grass you can possibly take, in order to understand the flowering system of the entire group, is that known to farmers and children as rye-grass, and technically described as *Lolium perenne*. It is a common roadside weed in every part of Britain, with a tall, stiff, blossoming stem, and a number of spiky flower-heads stuck on alternately upon either side of the stalk, which is deeply indented first on the right and then on the left, in order to make room for them. Each such flower-head is technically known as a spikelet, and it consists usually of some eight or ten tiny flowers, closely crowded together along the edge of a central stem or axis. The best way to understand the flowers is to begin with the lowest spikelet of the head, and pull off the flowers one by one, dissecting them with a pin as you go. The outer piece of all is an empty bract, which nearly encloses the whole spikelet, and keeps out unwelcome visitors, such as pollen-eating flies, weevils, and caterpillars. It is very stout, and thickly-ribbed, so as to serve its purpose of defensive armour. Next comes the lowest flower of the group, a degraded lily, so very degenerate that you would hardly guess at first sight the real relations of its parts. It is enclosed between two green organs, known as glumes, which are, in fact, the representatives of the three original calyx pieces. One of these, the outer, or "flowering glume," is large and convex, rolled round the edge of the other, which is thin and flat. The flat "inner glume," or "palea," has two green ribs near its middle, thus showing that it is really two calyx-pieces rolled into one. Removing these with your pin, very carefully, you come upon the actual floral organs. But where are the three petals? Ah! to find them you have to look very close indeed, and I won't guarantee that, without a lens, you will be able to see them at all. Still, if you have good eyes, you may possibly be able to make out two tiny white scales, very thin and almost transparent, between the outer glume and the base of the ovary. Those are the last faint relics of the two outer petals. As to the inner one, it has got crushed out of existence altogether by the mutual pressure of the florets against one another on the side turned towards the axis. The plant, in fact, had no further need for petals, since it does not now wish to attract insects; and therefore the real wonder is, not that one of them has disappeared, but that two of them should remain at all, even in the most rudimentary state, as evidences of their former presence. In many small grasses they have died out altogether; it is only in the larger kinds that any trace of them still exists. The stamens, on the other hand, being equally important to the plant under any circumstances, are there in full force—three of them, as in the lilies, but hanging out at the end of their long-waving filaments. Lastly, the ovary consists of a single cell, containing one rich seed, the grain which has given all the grasses their marked superiority in the struggle for existence. The remaining florets on the spikelet are each a repetition of this first pattern one; and the remaining spikelets of the head are similarly made up of an external enclosing bract and eight or ten small packed florets.

That, as I said, is the simplest general plan upon which all the grass-flowers are built up; but in most of them this

comparative primitive simplicity is largely obscured by the immense variety of devices for preventing thieving insects from getting at the grain or the pollen. For the very same insect interference which proves so beneficial to insect-fertilised plants is the deadliest danger of their wind-fertilised allies, and is guarded against by a profusion of minute devices which seems at first sight almost absurdly careful and petty. Pretty nearly any grass that you pick will show you these multiplied protective organs in a very advanced state of perfection. Here, for example, is a waving head of cock's-foot (*Dactylis glomerata*), which consists of numberless one-sided spikelets, clustered together into a closely-packed bundle, which only relaxes a little during the short time while the stamens and pistil are actually at maturity. Every spikelet consists of several little flattened florets, their outer glumes all ending in sharp, needle-like awns or beards, which effectually prevents flying insects from lighting upon them, either to probe the blossoms with their proboscis for the pollen, or to lay their eggs where the young grub might fatten on the richly-stored grain. Then, to keep out little creeping weevils, the glumes are strongly keeled, and down the keel runs a row of saw-like teeth, so that the insect would have to run the gauntlet of twenty little bottle-glass *chevaux-de-frise* (so to speak) before it could get at the food it was hunting. Every grass you can examine, almost, will supply similar instances of careful protective mechanism, all different in details, and all the same in general plan and purport. Sometimes, as in fox-tail (*Alopecurus pratensis*), the whole cylindrical flowering head is one soft mass of velvety hairs, in whose impenetrable forest the creeping insects lose their way hopelessly, while the flying ones cannot approach it by reason of the endless sharp points that stick out from it all round in every direction. At other times, as in wild barley (*Hordeum murinum*), the entire inflorescence bristles from head to foot with stiff bayonets, half the florets being here given up to purely protective functions, and enclosing no real floral organs at all, or only a few loose and imperfect stamens. Yet again, some kinds, like sweet vernal grass *Anthoxanthum odoratum*, have all the florets of each spikelet barren, save one only, so that insects which visit the outer empty chaff find nothing for their pains, and go away in despair without rifling the well-protected central floret. But the most remarkable of all these singular tricks on the part of the grasses is that practised by the common dog's-tail *Cynosurus cristatus*, which has its florets regularly arranged in double sets of spikelets, one outer and one inner, one at each joint of the stem. Of these, the outer spikelet is, so to speak, a mere waste, a bunch of empty scales, arranged in the shape of a fertile row, but without any stamens or any grain to justify its existence. It exactly covers and conceals the genuine spikelet that lies behind it, just as though one were to have a number of wax cherries hung up on the outside trees of an orchard, so as to take in the pilfering boys of the neighbourhood. One could spend days in describing all the various details of these protective grassy devices; but I have done enough, I hope, to show how interesting this branch of botanical study really is, and I may add that it is one of those where industrious amateurs may still hope to find out much for themselves that is as yet unknown, or but half understood, by the masters of the science. No group of flowering plants is harder to work at than the grasses; but no group better repays the time and trouble that may be spent upon it.

IT is said that the Torrens Bridge on the Grange Railway, South Australia, has sunk some inches owing to the use of heavy locomotives.

THE FISHERIES EXHIBITION.

NATURAL HISTORY DEPARTMENTS.

BY JOHN ERNEST ADY.

INTRODUCTORY. (*Continued.*)

LAST week we brought our visit to the Exhibition to a close at the termination of the Natural History galleries of the East Quadrant, and with it completed our survey of most of the important British exhibits concerned with our subject. We propose now to conduct the student over the ground principally devoted to the foreign sections, and thus to bring the narrative portion of our work to an end.

Let us commence where we left off, at the East Quadrant. We will not continue along the Eastern Arcade, the divisions of which are appropriated by exhibitors of fishermen's clothing, preserved diets, nautical instruments, diving apparatus, &c.; but will rather proceed into the open space, and glance at some of its interesting contents. Geographically defined, this space is bounded on the north by a large conservatory, in which a gorgeous royal barge, presided over by an equally gorgeous personage (not always on duty) is lodged. To the south of this, on the right and left hand sides, are two band-stands, surrounded by grass plots; and the whole of the space thus occupied is divided from the remainder by a transverse path running east and west, in the middle of which the Prince Consort's memorial is situated. The open ground is thus divided into two nearly equal portions; it is the southern part with which we shall have to deal. This latter is further subdivided by the large central pond into two lateral halves, and each half comprises two terraces, which overhang narrow, elongated (north and south) depressions, utilised as fresh-water tanks. To the western half we are allured by the huge skeleton of a whale which occupies its western terrace. This specimen is the property of the Marquis of Exeter, and is propped up on suitable supports. Its bones are coated over with luminous paint, and a few tickets suspended from the monster inform the public that it is erected in memoriam *Balæna mysticetus*, the Greenland or right whale, which yields, in place of the teeth it loses before birth, the whalebone of commerce, swims at the rate of about four miles an hour, and never exceeds 75 feet in length. We must not rest satisfied, however, with this meagre description, for the whale and its congeners, the porpoise, grampus, and dolphin, with their next of kin, the seals and walruses,* represent one of the most important items in the fisheries of the world, and we shall, therefore, recur to them in the descriptive portion of these papers. We shall then have occasion to guide the student to the stands where he may see the results of the various industries which have been developed from the great mammalian fisheries. So, in like manner, shall we conduct him to the stalls where he may view what commercial enterprise and artistic skill have done to utilise the various products which are the outcome of fish and fishing.

The terrace which contains the mortal remains of the whale overhangs an elongated tank, to which access may be gained down short flights of stairs at either end of the tank, within whose waters a large number of golden tench, common tench, carp, perch, and pike have been deposited by Lord Walsingham. The golden tench are particularly

* The seals and walruses belong to the aquatic *Carnivora*, the whale and its allies to the *Cetacea*, amongst mammalian animals; these two divisions are connected by a link now broken, and which is represented by the remarkable tertiary fossils of *Zeuglodon* and *Squalodon*.—J. E. A.

attractive; they have been bred from the original stock introduced into this country in 1852 by Mr. Berney, of Morton Hall, Norfolk.

The Eastern terraces, with their enclosed pond, crossed by a Chinese bridge, are now inhabited by fish-eating birds lent by the Zoological Society out of their collection in Regent's Park. The pelican of the wilderness and the curious flamingo are conspicuous amongst these; whilst at the extreme end of an aviary a dejected cormorant sits, deploring the fate which transported him from his birth-place in the Society's Gardens to the less congenial corner of a box in South Kensington.

The Chinese bridge, with its inconvenient steps, leads to a pagoda on its eastern side, and from thence a pathway directs us to the covered building assigned to China. Everything here is Chinese, from the carefully-executed drawings which deck the walls, and of some of which it may be appropriate to say, "These are fishes!" in a breath with the renowned artist of old who entitled his smear with the inscription, "This is a cow." Heterogeneity, rather than variety, seems to have been the aim of the Celestial curator whose pickled fish surround the pedestal, which is surmounted by a dilapidated boat containing a model Chinaman within and cormorants strewed without. The model serves its purpose, however, in conveying some idea of a novel mode of fishing which is even still employed by our Chinese brethren. The specimens of shells, &c., are chiefly confined to some of the commoner tropical forms, arranged anyhow and named somehow. In China it is a prevalent custom to make use of some of the larger turbinated shells (notably *Turbo olearius*) as hanging flower-pots; the outer layers of the shell are scraped away and reveal the beautiful nacreous lustre of the mother-of-pearl; a few of these may be seen in this department, and the work of M. P. Dabry de Thiersant* may be observed, safely locked in a glass-case. The roof which shelters China also protects the interests of India, the Straits Settlements, Japan, Chili, Hawaii, Tasmania, and New South Wales.

Although the exhibits of India are derived for the most part from the Government museums of that Empire, they seem to be a direct contradiction of the great law of evolution, the survival of the *un*fittest. Nothing short of the most unqualified reproach can be bestowed upon collections which we had hoped would vie with even those of Great Britain; but our disappointment is counterbalanced by the exquisite collection of Indian fishes, with illustrations from his valuable work, which stands out like a gem amidst a heap of rubbish; it is the property of a gentleman now resident in this country, and well known as a distinguished ichthyologist; we refer to Dr. Francis Day. The natural history collections from the Straits Settlements consist of a medley of the commoner forms of tropical corals, shells, and some unnamed fish in bottles of spirit.

The Asiatic exhibits come to a close with the Japanese division. On a central table there may be seen a box, exhibited by Messrs. Atkins and Nisbet, containing bundles of a whitish, semi-transparent, dried sea weed; this is the famous *Fucus cartilaginosus* of the Chinese and Japanese, which, when boiled with water and sugar, and allowed to cool in a mould, affords an alimentary substance somewhat like calf's-foot jelly in colour and consistency, but vastly different in taste.

Chili and Hawaii are not yet adequately represented, and the next exhibits of interest are those of Tasmania and New South Wales. These sections contain several handsome museum cabinets with well prepared stuffed specimens of fish and mammals, a choice selection of oyster shells (*Ostræa glomerata*), and the food fishes of Australia in spirit. This brings us to the end of the gallery from whence a short pathway leads to a narrow elongated building apportioned to Spain. We will not linger here, save to glance at a few specimens of wood perforated by the so-called ship worm (*Teredo*), whose true molluscous nature was first explained in an elaborate Latin memoir by G. Sellius.

The Spanish gallery terminates in the large central promenade of the Exhibition buildings, from which access may be successively gained (in respective order) to the seal and otter ponds, the buildings delegated to Norway, Sweden, Belgium, and the Netherlands, the United States of America, Canada, Denmark, and Newfoundland. To the west of the Canadian department there is a pond for beavers. Lastly, Russia is located—or rather not located—in a gallery corresponding on the west to that occupied by Spain on the east; and the building which here takes the position of the Australasian departments on the east is termed the Foreign Gallery, and lodges the chief Continental exhibits of Europe, those of the West Indies and Bahamas, and the Isle of Man.

We cannot do more here than merely indicate a very few of the interesting exhibits in each of the above-named departments. In the Norwegian section may be noticed a series of copied drawings from the originals of Professor Sars' work on the development of the cod, and also some of the plates taken from the reports of the Norske Nordhaus Expedition.

The Swedish section is richer in its natural history specimens; there may be seen some good skeletons of Cetaceans, lent by the Gothenburg Museum; several beautiful paintings in water colours, by W. von Wright, of the fishes of Sweden; and the collection made by Baron Nordenskjöld during the *Vega* expedition.

The United States of America have already arranged a large and well-chosen collection of specimens in their portion of the buildings, amongst which we may draw special attention to the cases of insects which serve as food for fishes, the collection of oyster (*Ostræa virginica*) and other shells, and a number of literary productions on fish and fish culture, conspicuous amongst which is an elaborate treatise on the game fish of the United States.

The Canadian dominion is fairly well represented; one of the chief attractions is a case containing specimens of fish caught in June and July, 1882, which even now seem to be comparatively fresh, decay having been arrested through a well-constructed freezing apparatus.

Belgium, Denmark, and the Netherlands are also well represented, although there seems to be a general lack amongst them of natural history specimens. The Newfoundland cod-fisheries find a small place in several beautiful commercial examples in bottles of spirits.

In the Foreign Gallery, Greece and Italy are rendered attractive through their corals and cameos. In one cabinet a large number of cameo-shells (chiefly of the genus *Cassis*), are arranged to show the progressive stages of the carving. Amongst other things in this gallery we may draw special attention to a very fine collection of bath sponges and pink pearls from the Bahamas, and to the only contribution which has as yet arrived from Austria,—a series of parasitic crustaceans found on Adriatic fishes, and described by Signor Antonio Valle.* The Foreign Gallery merges into the British departments allotted to pisciculture, through which we passed on a former occasion.

Lastly, in the south-eastern corner of the Exhibition buildings, a small shed is appropriated by the native Guano Company, and serves well to illustrate how a very far-

* "La Pisciculture et la Pêche en Chine."

* "Crostacei Parassiti dei Pesci del Mare Adriatico. Trieste, 1880.

fetched cause may tend to considerably influence and modify fish and fishing—viz., how the pollution of rivers can be obviated and turned to account. In the shed are exhibited specimens of native guano, precipitated from sewage by a peculiar mixture termed A B C; the precipitation is most perfectly effected, and all noxious substances are dissipated; the result of this is, that clear water flows off, freed from all injurious materials. Some of the water thus procured is shown to be perfectly harmless to fish in tanks and aquaria.

In conclusion, this narrative will be followed by a series of descriptive illustrated papers on the natural history exhibits. We propose to commence with the lowest forms of life, and to progress to those of higher organisation. In doing so we must obviously visit widely-separated stations in the Exhibition buildings, seek out and collect kindred specimens, and study them systematically.

DR. RAMSAY H. TRAQUAIR, M.D., F.R.S., Director of the Natural History Museum, Edinburgh, is now delivering a course of lectures (*free*) on the "Structure and Classification of Fishes." The first lecture was given on the 5th, and further lectures will be delivered at 4 p.m., on Tuesdays, Thursdays, and Fridays hereafter, till June 29.

PROF. HUGHES ON MAGNETISM.

BY W. SLINGO.

PRESSMEN were wont to say of speeches made by Mr. Lowe (Lord Sherborne) that they were so full of points, each essential to the rest, that to eliminate any of them for the purpose of condensation were well-nigh impossible. A similar difficulty presents itself to any one who ventures to epitomise the paper on "The Cause of Evident Magnetism," read by Prof. Hughes at a meeting of the Society of Telegraph Engineers on Thursday week. The paper contains matter that is certain to evoke the greatest interest in the minds of all who have hitherto given any, even the slightest, attention to magnetism. The chairman went so far as to say that nothing in magnetism so interesting in description, or so perfect in demonstration, had been brought before the scientific world since the time when Œrsted made public his great discovery concerning the relations between magnetism and electricity. These discoveries were of themselves sufficient to make telegraphy practicable, but whether or not Prof. Hughes' labours will affect the applications of magnetism to every-day life is matter of conjecture. It seems to me more likely that the science rather than the art (or the application of the science) will reap the reward. At the commencement of his paper, the Professor details the chaotic work and theories of previous experimentalists, Coulomb, Poisson, Ampère, De la Rue, Matteuci, Page, Joule, and Maxwell. He does so in order to show that they all "admit of the inherent polarity of the molecule"; but, he further observes, "the induction balance at once shows that they are erroneous in the most important part, for my researches have proved that neutrality is perfectly symmetrical, that there is no case of neutrality where the axes of the molecules are turned indifferently in all directions, and that we cannot obtain perfect neutrality except when the molecules form a complete closed circuit of attraction." Upon this basis, experimentally treated, Professor Hughes draws the following conclusions:—

1. That each molecule of a piece of iron, steel, or other magnetic metal is a separate and independent magnet, having its two poles and distribution of magnetic polarity exactly the same as its total evident magnetism when noticed upon a steel bar-magnet.

2. That each molecule, or its polarity, can be rotated in either direction upon its axis by torsion, stress, or by physical force such as magnetism and electricity.

3. That the inherent polarity or magnetism of each molecule is a constant quantity like gravity; that it can neither be augmented nor destroyed.

4. That when we have external neutrality, or no apparent magnetism, the molecules, or their polarities, arrange themselves so as to satisfy their mutual attraction by the shortest path, and thus form a complete closed circuit of attraction.

5. That when magnetism becomes evident, the molecules or their polarities have all rotated symmetrically in a given direction, producing a north pole if rotated in that direction as regards the piece of steel, or a south pole if rotated in the opposite direction. Also, that in evident magnetism, we have still a symmetrical arrangement, but one whose circles of attraction are not completed except through an external armature joining both poles.

6. That we have permanent magnetism when the molecular rigidity, as in tempered steel, retains them in a given direction, and transient magnetism whenever the molecules rotate in comparative freedom, as in soft iron.

Space will not permit me to give even a bare enumeration of the various admirable and ingenious experiments performed to demonstrate these deductions, but the pith of them all is I imagine in the third and fourth paragraphs, the others following as an almost natural sequence. Prof. Hughes has been materially assisted in his efforts to overcome previously-received notions of coercive force and neutrality, by his recent experiments on the effects of torsion, and by his invention of the induction balance. In demonstrating the principle of "inherent" magnetism, the professor maintains that a "bar of iron or steel, being held in the earth's magnetic field of infinite size compared with the bar, and infinitely homogeneous, cannot deflect or weaken its surrounding field." "We cannot," he says further on, "either by induction, conduction, or concentration, produce a greater force in another body of similar displacement or size, otherwise we could easily create power from a feeble source. Thus the enormously greater magnetic power observed in iron than the same column of air which it displaces must be due to the indirect polarity of its molecules." This polarity he ascertained in a certain piece of wire to be "15,600 times greater than the column it displaced." The effects of torsion are most remarkable. Torsion is capable of doing anything that can be performed by heat or by vibration. This was shown in many ways. A piece of iron, after being slightly magnetised, was by its means demagnetised. A piece of iron held in the magnetic dip was highly magnetised. A piece of untempered fine cast drill steel illustrated "superposed" magnetism in a remarkable manner. The wire, one millimètre thick, had two entire turns or twists to the right, and was then magnetised by passing it over the north pole of a magnet. It was then subjected to two turns to the left, and passed over the south pole of a magnet. When free from torsion the wire exhibits perfect neutrality, but when twisted either to the right or left polarity is evident. One of the prettiest experiments of the evening was with the aid of such a piece of wire. None of the apparatus was remarkable for its costliness, the most elaborate piece consisting of two footless wine-glasses, four penny bar-magnets, and a short piece of thin steel. The steel was movable in a horizontal plane over the bar-magnets, and was therefore polarised.

If moved far enough in either direction, it struck one of the glasses, producing a musical sound. The superposed magnetic wire on being brought near the piece of steel and twisted alternately to the right and left, repelled and attracted it, and caused it to strike the glasses with unerring distinctness. The effect was marvellous, and Prof. Hughes may be pardoned for taking a little pride to himself for showing "the first direct transformation of

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molecular motion into mechanical movement." I ought, perhaps, to mention one other experiment performed to illustrate the molecular homogeneity (as opposed to the generally received theory of haphazard intermingling) when in a state of neutrality. A complete ring of steel wire, ten centimètres in diameter, was revolved over the pole of a magnet and gradually withdrawn, the revolution being maintained until removed some feet from the magnet. Such a ring is perfectly neutral, and exhibits no polarity, although it would do if made to simply touch the magnet. On cutting or snapping the ring, very strong polarity becomes evident, and, therefore, excellent testimony is borne to the position taken up by Prof. Hughes.

Assuming that what Professor Hughes advances is correct—and I, for my part, can see no reason for doubting it—what is the effect upon our conception of magnetism? There will not be wanting those who will maintain that if we deprive the Ampèrian theory of the electric currents, we shall get Hughes's theory. But if we so treat Ampère's propositions we rob them of their one beauty. The molecular theory is one which has been at least suspected by many electricians, but to Professor Hughes belongs the credit of assigning to magnetism a place by the side of gravity, two forces which are indestructible and inconvertible. Magnetism can never be changed to any other form of force, although it may be made a channel of transference. It is therefore most completely separated from electricity—a form of force which, like heat, may be imparted or withdrawn, converted or destroyed.

LAWS OF BRIGHTNESS.

III.

By Richard A. Proctor.

NEXT let us consider the relative absolute brightness of the planets under different circumstances.

In the first place, let us inquire what is the total quantity of light sent from a hemisphere (smooth), illuminated and viewed in the same directions:—

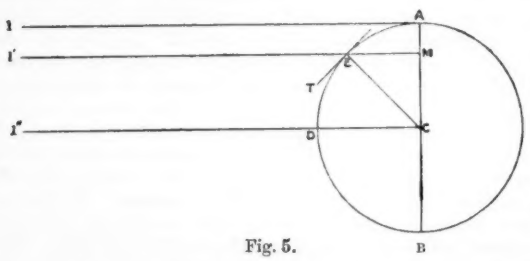

Fig. 5.

Let A D B (Fig. 5) be a section of the illuminated hemisphere, the lines of light being as I A, I' E, &c. Let D be the middle of the visible disc, E another point. Then the illumination has its maximum value at D. At E it is less in the ratio of the sine of the angle T E I'. But the angle E C A is equal to the angle T E I', and the sine of the angle E C A is the ratio E M to E C. Hence the illumination at E is less than that at D in the ratio of E M to E C—that is, of E M to D C. So that if we represent the illumination at D by the line D C, the illumination at E will be represented by the line E M. Now let A B (Fig. 6), represent the disc shown by the hemisphere, growing gradually fainter to the edges; and let A' B' (Fig. 7) be a flat disc illuminated all over as the hemisphere is illuminated at D. Then, if *a d b* be an ideal hemisphere corresponding to the illuminated hemisphere A D B in dimensions, *e* corresponding to E and *d* to D, we have seen that if *d c* represent the brightness at D, *e m* will represent the brightness at E; so that obviously if the small solid space *d c* represent the total light from the small area D, the small solid space *e m* will represent the total light from the small area at E. Hence, supposing the whole disc divided into a number of very small areas, such as those at E and D, we see that when all the corresponding small solid spaces have been taken into account, we get the total light from the disc represented

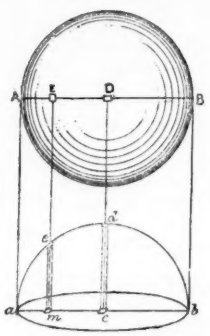

Fig. 6.

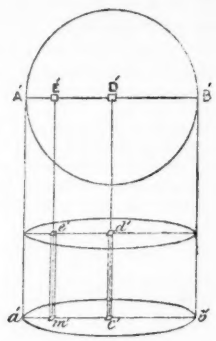

Fig. 7.

by the volume of the hemisphere *a d b*. Doing the like for the flat disc A B (and retaining the same scale of construction) we get the total light from the flat disc, represented by the volume of the cylinder *a' d' b'*, whose base *a' b'* is equal to *a b*, and its height *d' c'* equal to *d c*. Now, the volume *a d b* is two-thirds of the volume *a' d' b'*, by Archimedes' property of the sphere and cylinder. Hence the total light received from a hemisphere, both illuminated and viewed directly, is two-thirds of the total light from a flat surface equal to the great circular section of the hemisphere, and illuminated directly.

This relation only enables us to estimate and compare the brilliancy (total) of the superior planets in opposition (for Venus and Mercury in superior conjunction may be left out of consideration). We may apply the relation at once to determine the theoretical relative brilliancies of the superior planets, on the supposition—first, that they are smooth spheres; and secondly, that their surfaces are of equal reflective power. It will be understood, of course, that by reflective power is understood the power of returning light by general reflection, the quality which makes opaque bodies look more or less bright under the same circumstances of illumination. Zöllner calls this quality the *albedo*, or, as it were, the *whiteness* of surfaces.

Now, obviously, all we have to do, to determine the theoretical relative brilliancy of the superior planets in opposition, is to multiply the number representing the area of each planet's disc into the number representing its illumination. For we have seen that the total brightness of a planet in opposition bears a constant ratio to that of a flat disc illuminated directly and looking precisely as large as the planet. Now, the apparent diameter of a planet at any time varies as its real diameter divided by its distance, so that the apparent size of its disc varies as $\left(\frac{\text{real diameter}}{\text{distance}}\right)^2$. We have only to multiply this by the number representing the illumination to get the relative total brilliancy. The following table gives the results. In calculating it the

diameters of the planets have been assumed to be as follows :—

	Diameter. Miles.
Mars	4,400
Jupiter	85,000
Saturn	70,000
Uranus	36,000
Neptune	37,000

The mean distances and eccentricities as in the usual table of elements.

Then we get the following table :—

RELATIVE THEORETICAL TOTAL BRILLIANCY OF THE SUPERIOR PLANETS IN OPPOSITION.

Mars at mean distance from sun	1,000
,, in perihelion	2,302
,, in aphelion	519
Jupiter at mean distance	487
,, in perihelion	624
,, in aphelion	405
Saturn (without rings) at mean distance	24·5
Uranus at mean distance	0·30
Neptune at mean distance	0·58

It will be seen at once that the theoretical relative brilliance of Mars and Jupiter differ markedly from the observed brilliancy of these planets. Mars in opposition at his mean distance is not so bright as Jupiter in opposition, yet theoretically he should be more than twice as bright as Jupiter in opposition at his mean distance. Mars in opposition in perihelion ought to be more than three times as bright as Jupiter in opposition in perihelion, and more than five times as bright as Jupiter in opposition in aphelion.

It will also be recognised that Mars when in opposition at his mean distance is not forty times brighter than Saturn when in opposition, with his ring edgewise, or nearly so, as during the years 1860-62.

We see, then, at once, even from these elementary considerations applied to the brightness of the planets as seen by the naked eye, that there is a marked distinction between the planets Jupiter and Saturn on the one hand, and Mars on the other. This instance serves to illustrate the interest attaching to the photometrical study of the planets.

(To be continued.)

CREMATION.

I FANCY "A Brother Cinder" is rather "chaffing" in his letter on cremation, which, if it be so, is a pity. The subject is a very serious one, and, with the present state of our population and cemetery rites, an important one in a sanitary point of view. Of course, in advocating the disposal of the dead by cremation, one has to contend against perhaps the strongest antagonist it is possible to encounter—public prejudice. Added to this is the circumstance that the proper method is but imperfectly understood in this country. Still, as our intercourse with countries in which cremation obtains increases, and our knowledge of the proper method becomes more perfect, it is to be hoped that the practice will be more common.

If your space will allow of it, I should like to make a few remarks upon this subject. It is one I wrote upon in the public papers more than fifteen years ago; indeed, I think as almost one of the first advocates of the process. Its advantages over sepulture appear to me to be :—1st. Cleanliness and purity. 2nd. In a sanitary point of view. 3rd. In expense. 4th. In solemnity.

On the two first points nothing need be said, they are so perfectly self-evident. With regard to expense, if properly carried out, the first expense would not exceed that of an ordinary burial, and the after-expense of mausoleums, tombstones, and railing would be saved, although, of course, tablets, &c., would remain the same. As touching solemnity, of course, as few in England have seen the process, it is difficult to convey an adequate idea of the feelings it would engender. I can only say, that having myself attended a cremation, as well as many a burial at sea and on shore, the former carries away the palm far and away for solemnity.

The first cremation I saw was at Bangkok, in Siam. It took place in a grove as the evening fell. A large kind of brick-bath, with a ledge round it of about two feet in width, filled level to the full with some incandescent fuel, apparently charcoal. From each corner of the fire sprang an arch, meeting over the centre in a dome. It appeared as if this was always kept burning at the level of the full. The situation was in a quiet, retired grove outside the city. The corpse was brought by bearers, with priests in advance and the relations in rear; much, indeed, as our own funeral order is used in England. The coffin—of wood, and probably filled with aromatic chips of wood—was placed on the wide ledge, and the funeral rites performed, after which it was gently pushed upon the incandescent fire. I watched it carefully. It appeared to gradually sink quietly down into the fuel below, and to become itself part of that fue There was scarcely any smoke, and *no smell whatever.*

I have very imperfectly described that cremation. But it left upon my mind, as in that silent grove the mourners stood around, and the boughs of the trees drooped overhead, and the summer's evening breeze swept through them —it left, I say, upon my mind a feeling of peace and solemnity that I have failed to realise at the launching of any corpse into the blue sea, or the burial of any body in the damp earth.

I will not trench upon your space farther than to say that I hope at some time prejudice may be overcome, and solemn and healthy cremation have its place amongst us. Two things I have omitted to mention; one, that I think the majority of old Indian officers will be found on the side of cremation. The other, that for the preservation of the bones, it is only necessary to envelope the corpse in an asbestos sheet, which is subsequently withdrawn.

PERCIVAL A. FOTHERGILL, B.A., F.R.A.S.

THE CHEMISTRY OF COOKERY.

XI.

BY W. MATTIEU WILLIAMS.

ALWAYS keeping in view that the primary problem in roasting is to raise the temperature throughout to the cooking heat with the smallest possible degree of desiccation of the natural juices of the meat, and applying to this problem the laws of vapour diffusion expounded in my last, it is easy enough to understand the theoretical advantages of roasting in a closed oven, the space within which speedily becomes saturated with those particular vapours that resist further vaporization of these juices.

I say "theoretical," because I despair of practically convincing any thoroughbred Englishman that baked meat is better than roasted meat by any reasoning whatever. If, however, he is sufficiently "un-English" to test the question experimentally, he may possibly convince himself. To do this fairly, a large joint of meat should be equally divided, one half roasted in front of the fire, the other in a non-ventilated oven over a little water by a cook who knows

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how to heat the latter. This condition is essential, as some intelligence is demanded in regulating the temperature of an oven, while any barbarian can carry out the modern modification of the ordinary device of the savage, who skewers a bit of meat, and holds this near enough to a fire to make it frizzle.

Having settled this question to my own satisfaction more than twenty years ago, I now amuse myself occasionally by experimenting upon others, and continually find that the most uncompromising theoretical haters of baked meat practically prefer it to orthodox roasted meat, provided always that they eat it in ignorance.

Part II. of Count Rumford's "Tenth Essay" is devoted to his roaster and roasting generally, and occupies 94 pages, including the special preface. This preface is curious now, as it contains the following apology for delay of publication:—"During several months, almost the whole of my time was taken up with the business of the Royal Institution; and those who are acquainted with the objects of that noble establishment will, no doubt, think that I judged wisely in preferring its interest to every other concern." To those who have attended the fashionable gatherings held on Friday evenings in "that noble establishment" during the London season, it is almost comical to read what its founder says concerning the object for which it was instituted, viz., the noble purpose of DIFFUSING THE KNOWLEDGE AND FACILITATING THE GENERAL INTRODUCTION OF NEW AND USEFUL INVENTIONS AND IMPROVEMENTS." The capitals are Rumford's, and he illustrates their meaning by reference to "the repository of this new establishment," where specimens of pots and kettles, ovens, roasters, fireplaces, gridirons, tea-kettles, kitchen-boilers, &c., might be inspected.

Some years ago, when I was sufficiently imprudent to accept an invitation to describe Rumford's scientific researches in *one* Friday evening lecture, rigidly limited to fifty-seven minutes (and consequently muddled my subject in the vain struggle to condense it), I tried to find the original roaster, but failed; all that remained of the original "repository" being a few models put out of the way as though they were empty wine-bottles. I am not finding fault, as the noble work that has been done there by Davy, Faraday, and Tyndall must have profoundly gladdened the supervising soul of Rumford (supposing that it does such spiritual supervision), in spite of his neglected roaster, which I must now describe without further digression.

It is shown open and out of its setting in Fig. 1, and there seen as a hollow cylinder of sheet-iron, which for ordinary use may be about 18 inches in diameter, and 24 inches long, closed permanently at one end, and by a hinged double door of sheet-iron (*dd*) at the other. The doubling of the door is for the purpose of retaining the heat by means of an intervening lining of ill-conducting material.

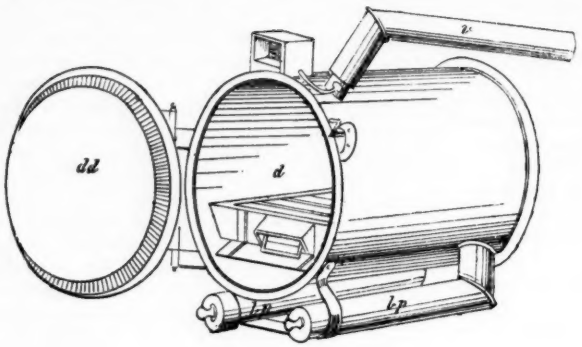

Fig. 1.

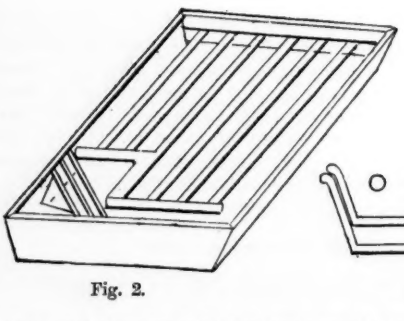

Fig. 2.

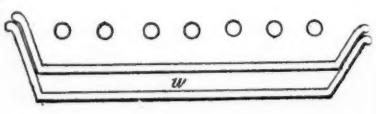

Fig. 3.

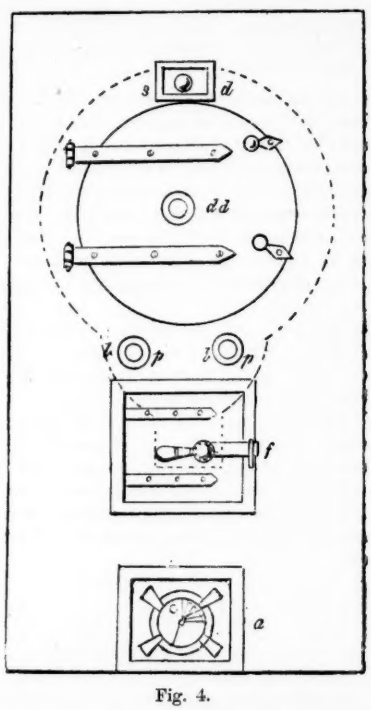

Fig. 4.

Or a single door of sheet-iron, with a panel of wood outside, may be used. The whole to be set horizontally in brickwork, as shown in Fig. 4, the door front being flush with the front of the brickwork. The flame of the small fire below plays freely all round it by filling the enveloping flue-space indicated by the dotted lines on Fig. 4. Inside the cylinder is a shelf to support the dripping-pan (*d*) Fig. 1, which is separately shown in Figs. 2 and 3.

This dripping-pan is an important element of the apparatus. Fig. 3 shows it in cross section, made up of two tin-plate dishes, one above the other, arranged to leave a space (*w*) between. This space contains water, half to three-quarters of an inch in depth. Above is a gridiron, shown in plan, Fig. 2, on which the meat rests; the bars of this are shown in section in Fig. 3. The object of this arrangement is to prevent the fat which drips from the meat from being over-heated and filling the roaster with the fumes of "burnt," *i.e.*, partially decomposed, fat and gravy, to the tainting influence of which Rumford

attributed the English prejudice against baked meat. So long as any water remains the dripping cannot be raised more than two or three degrees above 212°.

The tube *v*, Fig. 1, is for carrying away vapour, if necessary. This tube may be opened or closed by means of a damper moved by the little handle shown on the right. The *heat* of the roaster is regulated by means of the register *c* in the ash-pit door of the fireplace, its *dryness* by the above-named damper of the steam tube *v*, and also by the blowpipes, *b p*.

These are iron tubes, about 2½ in. in diameter, placed underneath, so as to be in the midst of the flame as it ascends from the fire into the enveloping flue, shown by the dotted lines, Fig. 4, where their external openings are shown at *b p*, *b p*, and the plugs by which they may be opened or closed in Fig. 1. It is evident that by removing these plugs and opening the damper of the steam pipe a blast of hot, dry air will be delivered into the roaster at its back part, and it must pass forward to escape by the steam pipe. As these blow-pipes are raised to a red heat when the fire is burning briskly, the temperature of this blast of air may be very high; with even a very moderate fire, sufficiently high to desiccate and spoil the meat if they were kept open during all the time of cooking. They are accordingly to be kept closed until the last stage of the roasting is reached; then the fire is urged by opening the ash-pit register, and when the blow-pipes are about red-hot their plugs are removed, and the steam-pipe damper is opened for a few minutes to brown the meat by means of the hot wind thus generated.

It will be observed that a special fire directly under the roaster is here designed, and that this fire is enclosed in brickwork. This is a general feature of Rumford's arrangements, which I shall have to discuss more fully when I come to the subject of kitchen fires. The economy of the whole device will be understood by the fact that in a test experiment at the Foundling Institution of London, he roasted 112 lb. of beef with a consumption of only 22 lb. of coal (three pennyworth, at 25s. per ton).

Rumford tells us that "when these roasters were first proposed, and before their merit was established, many doubts were entertained respecting the taste of the food prepared in them," but that, after many practical trials, it was proved that "meat of every kind, without any exception, roasted in a roaster, is *better tasted, higher flavoured, and much more juicy and delicate* than when roasted on a spit before an open fire." These italics are in the original, and the testimony of competent judges is quoted.

I must describe one experiment in detail. Two legs of mutton from the same carcass made equal in weight before cooking were roasted, one before the fire and the other in a roaster. When cooked both were weighed, and the joint roasted in the roaster proved to be heavier than the other by 6 per cent. They were brought upon table at the same time, "and a large and perfectly unprejudiced company was assembled to eat them." Both were found good, but a decided preference given to that cooked in the roaster, "it was much more juicy, and was thought better tasted." Both were fairly eaten up, nothing remaining of either that was eatable, and the fragments collected. "Of the leg of mutton which had been roasted in the roaster, hardly anything visible remained, excepting the bare bone; while a considerable heap was formed of scraps not eatable which remained of that roasted on a spit."

This was an eloquent experiment; the 6 per cent. gained tell of juices retained with consequent gain of flavour, tenderness, and digestibility, and the subsequent testimony of the scraps describes the difference in the condition of the tendonous, integumentary portions of the joints, which are just those that present the toughest practical problems to the cook, especially in roasting.

But why are these roasters not in general use? Why did they die with their inventor? I will take up these questions in my next.

Editorial Gossip.

THE story of the three black crows might be matched by some stories spread with modifications by newspapers. Two years or so ago I learned quite a number of new things about myself from some papers in America, which certainly meant all in kindness which they wrote; and, knowing precisely what the grain of truth was around which had gathered these accumulations of error, I was more amused than annoyed at the mis-statements which came under my notice. But I should have liked to trace the growth of error, to see precisely how a trivial matter had grown into something surprising and almost portentous. In particular, I should like to have known how a column or so of nonsense, which appeared in I know not how many American papers, under the title of "Professor Proctor's Romance," came into being—by what process of evolution it was developed from one little germ of truth contained in it.

WHAT has recalled this amusing experience to me has been the receipt of news from Australia that, "according to home papers, Mr. R. A. Proctor has taken to wearing stays." Readers of KNOWLEDGE will perhaps be rather surprised at this item of news, seeing that I have rather roundly ridiculed in these columns the practice of wearing stays (at least, if tightly-laced), even by those who, perhaps, have right and reason to wish to improve the figures Nature has given them. But to me the chief interest arises from the recognition of the rapid growth of error around a little germ of truth. Consider how robust the seedling must have been to germinate in this remarkable way:—I mentioned, only a few months ago, that once upon a time, having seen it stated and asseverated that wearing—not stays—but a broad waistband, with a strong and rather long busk—had led to rapid diminution of weight, I had thought it worth while to try the experiment; and that in my case, at any rate, the experiment had altogether failed. So much for the germ of truth. I might have added a few details, if I had cared, which would perhaps have robbed the story of some of the attractiveness which it seems to have had for the anonymuncules of the press. For instance, the thing happened fourteen or fifteen years ago, when, being but recently "turned thirty" (whatever that expression may signify), I might not have reached that unconcern about figure which, Anthony Trollope has told us, comes on men who have reached the forties. But again, the question of figure had nothing to do with my anxiety to be rid of superfluous fat, but—a rather more serious matter—a certain unwillingness to die before my time. I had been threatened with sudden cessation of circulation such as had, only two years before, befallen a sister (whose constitution resembled my own), and through the same cause, fatty oppression of the heart. I had been willing enough, till thus threatened, "to expand wisibly," and to receive from the earth increased attentions in the way of gravitation; but I did not want to go to earth altogether for awhile, if I could help it. An experimental attempt (and a failure at that) to reduce my weight through waist compression, fifteen years or so ago, referred to casually in KNOWLEDGE, comes back to me from the Antipodes, after

little more than time to get there and back, in the form of a recent definite recourse to corsets—now, when I am considerably past the age at which every man is either a fool or a physician.

NATURALLY, my good friends of the Melbourne press make some little fun of this three-black-crows item of news. I should be fair game, were it true. If it is of any interest to them (as apparently it is) to note such matters, I may mention that when I made the experiment in question, *twelve years* before my visit to Australasia, I weighed 14 st. 7 lb., whereas during the time of my visit to them I drew but 11 st. 10 lb.; and even now only 12 st. 6 lb.

A LETTER in the *Times*, signed C. Pritchard, presumably from the Rev. Charles Pritchard, Savilian Professor of Astronomy at Oxford, speaks of the advantage of the study of the Greek language. Mr. Pritchard's repugnance to a scheme by which the degree of Bachelor of Natural Science might be obtained without the necessity of passing a previous examination in Greek, arose, it appears, "from a life-long experience of the educational advantages derivable from a study of the Greek language and literature." The world had, it seems, "misapprehended the motives which induced some of us Museum Professors to vote against" that scheme. "I, with others," says Mr. Pritchard, "felt that it was an invidious thing to single out us poor science men as the only university students desirous of escaping Greek." Whether Professor Adams or Professor Cayley, or, in fact, any university professor who has made a name in science, would trouble himself to express strong repugnance lest he, not being a "poor" science man, should be suspected of ignorance of Greek, is a question which may occur to some who know how very much one professor differs from another in distinction. One can imagine (*àpropos des bottes*) that Æsop's daw, conscious of questionable tail-feathers, might have insisted on the beak as a feature which a life-long experience had taught him to regard as all-important among birds.

SERIOUSLY, if the opinion of science is to be taken on the question of the study of Greek by those who go in for degrees in Natural Science, one would like to have the opinion, *not* of "poor" science men, but of the real men of science who honour the universities by holding professorships there. Professor Adams, co-discoverer of Neptune with the great Leverrier, Professor Cayley, the greatest master of pure mathematics living, and men of like standing, are rather annoyingly silent on this subject; Professor Pritchard, author of ?—, discoverer of ?—, inventor of ?—, but promiser of new lunar theories, and like loud-sounding nothings, is scarce less annoyingly voluble.

STILL, Professor Pritchard's exceptional familiarity with Greek language and literature may, perhaps, entitle him to speak. I remember once, when a new and atrocious addition to astronomical nomenclature was under discussion before the Astronomical Society, I objected strongly, and I am glad to think effectively, to the proposed word—*leucosphere* (or white sphere)—on the ground, among other more important reasons, that the word, judged by its sound, would be mistaken for wolf-sphere; on which I was told by Professor Pritchard, considerably to my astonishment, that the Greek for a wolf was "not λύκος, but λύπος." This singular discovery was perhaps one of the results of "a lifelong experience of the educational advantages arising from a study of the Greek language and literature." Professor Pritchard must be almost as well fitted to speak with authority on this point as on questions suited to "poor science students."

Reviews.

THE PAST OF OUR EARTH.*

BY RICHARD A. PROCTOR.

THIS would not be the place for a review, properly so-called, of the masterly treatise before us, full as it is of matter which, though exactly described and dealt with, cannot be said to be plainly worded. So far as this book is to be regarded as a mathematical treatise, it is outside our lines; we need only note that the mathematical treatment of the subjects dealt with is thorough and admirable, and even that will be no news to those whom it alone concerns — advanced mathematicians — seeing that the names of Professors Thomson and Tait are a guarantee for profound and accurate investigation of all subjects falling within the range of mathematical inquiry.

But matters are dealt with in this work, which, though here treated in a way which only mathematicians can follow, are full of interest to all students of science. Among these are (1) the subject of the tides, admirably dealt with in the present work, in sections 798–811; (2) the effects of tidal friction (sections 830, 831, and Appendix G) and their connection with what is commonly termed the lunar acceleration, though analogy would suggest the use of another expression†; (3) the condition of the earth's interior (sections 832–846; (4) the secular cooling of the earth; (5) the age of the sun's heat; (6) and the size of atoms.

In dealing with the cooling of the earth, Professor Thomson maintains that, on the whole, there is reason for regarding as probable those geological speculations which assume somewhat greater extremes of heat, some violent storms and floods, more luxuriant vegetation, and hardier and coarser-grained plants and animals in remote antiquity. "A middle path," he says, "though not generally safest in scientific speculations, seems to be so in this case. It is probable that hypotheses of grand catastrophes, destroying all life from the earth, and ruining its whole surface at once, are greatly in error;" but, on the other hand, "it is impossible that hypotheses assuming an equality of sun and storms for 1,000,000 years can be wholly true."

In the same interesting portion of the work before us, Sir W. Thomson, speaking of an opinion advanced by Sir Charles Lyell, respecting the possible maintenance of the earth's heat without change throughout countless ages, uses words which may be applied without change of a word to the stupendous theory advanced by Sir C. Siemens not so very long since—such an idea of a practically endless cycle "violates the principles of natural philosophy in exactly the same manner, and to the same degree, as to believe that a clock constructed with a self-winding movement may fulfil the expectations of its ingenious inventor by going for ever." The earth is necessarily cooling from century to century; her volcanic energies are certainly diminishing, as certainly, to use an illustration of Sir W. Thomson's, as the quantity of gunpowder in a "monitor" is diminishing when hour after hour she is seen to discharge

* "Treatise on Natural Philosophy." By Professors Sir W. Thomson and P. G. Tait. Vol. I., Part II. (Cambridge University Press.)

† It is well pointed out by our authors that the ordinary use of the expression "lunar acceleration" is as incorrect as would be the use of the word "acceleration" to describe the fall of a body in whatever period is taken as the unit of time, and the common but really absurd mistake of speaking of a clock as so many seconds or minutes fast, when in reality it is only by so much in advance of true time. The authors of the work before us suggest the use of the words "lunar advance" to express what has hitherto been erroneously called "lunar acceleration."

shot and shell, whether at a nearly equable rate or not, without receiving fresh supplies of ammunition.

Professor Thomson is led by a consideration of the necessary order of cooling and consolidation of the earth, to infer that the interior of our world is not, as commonly supposed, all liquid, within a thin, solid crust of from 30 to 100 miles thick, but that it is on the whole more rigid than a continuous solid globe of glass of the same diameter, and probably more rigid than such a globe of steel.

ORGANIC CHEMISTRY.*

ORGANIC chemistry—or, more correctly, the chemistry of the carbon compounds—is regarded by many as a dry and disagreeable study—the mere investigation of alkaloids. Yet it is, in truth, the key to the study of life. It is a study calling into exercise not only observation and experiment, but close and careful reasoning. The book before us has dealt with this important subject—as fully and completely as could possibly, we think, be done within its limits—in such a way as to prepare the student to read understandingly, and with interest, the literature of organic chemistry. It is intended as a textbook, not a dictionary, of compounds, or a work of reference. It seems admirably adapted for the purposes of the teacher. In particular we must recommend the system by which, at the end of each group, there is a retrospect, reviewing the compounds considered, and surveying the typical reactions and inter-relations of the various classes of substances. These retrospects, following on the detailed facts relating to each group, are much more intelligible and much more useful to the student than they can be as sometimes presented—that is, as broad generalisations respecting groups of compounds with which the student is little acquainted. Dr. Austen has preserved the pleasant lecture style of Prof. Pinner's book, and he has added the more important recent discoveries in organic chemistry, making free use of suitable text-books and works of reference. The book is one we can cordially recommend to students of organic chemistry.

EUROPEAN MINERAL WATERS.†

MINERAL waters are so often recommended as specific remedies for diseases, or for conditions threatening disease, that it is well to have trustworthy statements respecting their real value. There are those who assert that the "waters" themselves have less to do with the benefits attained from spas than the regimen enjoined. But no physician doubts the efficacy of magnesium and soda salts, though many would be perplexed to define the precise results which might be expected—apart from regimen—to follow the use of mineral waters of complex composition. Be this as it may, it is important to have a trustworthy work of reference, like this book before us, in regard to the chief mineral waters. In particular it is well that the errors repeated in many of the books about mineral waters (errors largely arising from changes which have taken place in the composition of these waters) should be corrected. This has been done, and done well, in Dr. Tichborne's work. The waters have been either examined specially for this purpose, or use has been made of the work of recent analysts of competent skill. The new analyses are nearly one hundred in number, and represent work extending over three years. The chapters on the therapeutical action and uses of the several mineral waters, by Dr. Prosser James (which alternate with those written by Dr. Tichborne) are based on practical knowledge, obtained at the source of many of the most important waters.

* "An Introduction to the Study of Organic Chemistry." By Adolph Pinner, Ph.D., Professor of Chemistry in the University of Berlin. Translated and revised from the fifth German edition by Peter T. Austen, Ph.D., F.C.S., Professor of Chemistry, Rutgers College, and the New Jersey State Scientific School. (London: Trübner & Co.)

† "The Mineral Waters of Europe; including a short description of Artificial Mineral Waters." By C. R. C. Tichborne, LL.D., F.R.C.S., &c., and Prosser James, M.D., M.R.C.P. (London: Baillière, Tindall, & Cox.)

POEMS FOR PENNY READINGS.*

FOR Penny Readings some folks fancy such poems and ballads as Tennyson, Scott, Burns, Adelaide Procter, Aytoun, and some other poets known rather favourably to fame, have written. But *this* fault is to be found with all such poems—the reader must always be to some degree doubtful whether the applause which follows the reading is due to the beauty of the poem or to the ability with which it has been read. The great merit of the collection before us is that it leaves room for no doubt of this sort. We know of no seriously intended poems better in this respect, and only of one poem better among those not so intended—to wit, the one which relates to "Lost Mr. Blake." A reader who could move the feelings and rouse emotion by the sweet poem which begins—

> Mr. Blake was a regular out-and-out hardened sinner,
> Who was quite out of the pale of Christianity, so to speak;
> He was in the habit of smoking a long pipe and drinking a glass of grog on a Sunday after dinner,
> And seldom thought of going to church more than twice or—if Good Friday or Christmas Day happened to come in it—three times a week,

might be as successful with Agra's poems and ballads.

The volume opens with a poem after (rather a long way after) the Burial of Moore. It relates to Lieut. Brookes, at Tel-el-Kebir, beginning, and also closing, with the touching lines:

> Bury him in the blood-stained sand,
> On the spot where he bravely fell,
> With his broken spade in his cold right hand—
> The spade that he swung so well.

But "The Water-logged Barque" is, to our taste, the finest thing in the book. At the outset the barque was under full sail, "a mountain of snow, inexpressibly grand," the "royals glancing in the light of the morning sun;"

> "While the foresail, bulging out before,
> Swell'd in the breeze still more and more,
> Seem'd, as it were, a cathedral dome
> Dark in the shadow."

But the skipper saw that this was no time

> "To gaze
> On the snow-white canvas' towering maze,"

So he

> "Spoke to the mate, who sung out the hail,
> 'Get in the flying jib and the gaff top-sail.'"

So actively did the crew attend to this and "succeeding orders following fast," that "the main-sail was stow'd ere noon was past;" and even this work of stowing the main-sail in a few hours did not show the full activity of the crew; for some of them had been below, whence, however, they were called.

> The ship was stripp'd and close reef'd at last,
> The weather changed, it began to blow.

* "Poems and Ballads for Penny Readings." By Agra. (Wyman & Sons. London.)

Then

Fiercer still the wild storm-blast grew,
The sea changed at once from deepest blue
To a dark and greasy, sloppy green.

But even this unpleasant state of things only heralded worse, for—

As squall followed squall in infernal roar,—
Such an awful tumult I'd ne'er heard before.
Who e'er would have thought but a few hours past
That such fearful weather for a week could last?

The barque was thrown on her beam ends, and though "now and then when it ceased to blow we righted a moment' it was

"Only to fall
Down flat with a jerk that electrified all;"

Evidently the crew had a shocking bad time. The worst of the trouble, however, was to come. The ship after several days sprang a leak, which blanch'd every cheek, for

'twas awful to think
That our cargo was such *that she could not sink.*

Therefore, all hands naturally went to the pumps; but as she could not sink,

we worked in vain,
For days we kept up the fearful strain,
Till the useless toil severely told.
We left off exhausted, worn out, one by one—
The skipper admitted no more could be done.

There is nothing more impressive, perhaps, in modern poetry than this, unless it be found in Gilbert's touching lines—

For a month we'd neither wittles nor drink,
Till a hungry we did feel.

Being rather tired after working several days at the pumps, the crew

"wish'd she'd sink,
But knew she would not; there on the brink
Of death ever present days we stood
Lash'd to the poop-rails."

How the crew of the water-logged barque was eventually saved, we leave the penny-reader to disclose, sure that every soul in an audience which has heard the whole of this poem—the gem of the collection—will feel with him as he utters the closing lines—

"of all I've passed through in my day,
That most miserable time bears the blackest mark,
For the worst of all was 'The Water-logged Barque.'"

Some of the other poems in the volume are almost equally fine, yet none quite so grand as this one.

THE FACE OF THE SKY.

FROM JUNE 8 TO JUNE 22.

BY F.R.A.S.

THE period of maximum Solar disturbance has now certainly passed, but watch should still be kept for occasional outbreaks of spots, etc. The face of the night sky will be found delineated in Map VI. of "The Stars in their Seasons." Twilight now persists all night long in the British Islands; hence it is an unfavourable time for observing nebulæ and similar objects. As regards the planets, the heavens are really a practical blank during the next fortnight, Mercury, Mars, Jupiter, Saturn, Uranus, and Neptune being quite invisible, and Venus only twinkling as a little disc less than 12″ in diameter near the eastern horizon just before sunrise. The moon's age at noon to day (8th) is 3·2 days, and on the 22nd obviously she will be 17·2 days old. Hence from the 8th to the 17th, and on the 21st and 22nd she will be in a succession of favourable phases for the observer with the telescope. Four occultations (all of 6th magnitude stars) will occur at convenient hours during the period of which we are treating. The first happens on June 10, when 14 Sextantis will disappear at the moon's dark limb at 9 h. 10 m. p.m. at an angle of 130° from her vertex, and reappear at 10 h. 6 m. p.m. at her bright limb at an angle of 262° from the vertex of the moon. On the 14th 50 Virginis will disappear at the dark limb at 8 h. 54 m. in the evening at an angle from the moon's vertex of 104°; reappearing at 10 h. 8 m. p.m. at her bright limb at a vertical angle of 252°. On the 17th 41 Libræ will disappear at midnight at the moon's dark limb at an angle of 23° from her vertex; to reappear 14 minutes later at her bright limb at an angle from her vertex of 5°. Finally 16 Sagittarii will disappear at the bright limb of the moon at 8 h. 55 m. p.m. on June 20, at an angle of 29° from her vertex. It will really reappear at her dark limb, but she will be so nearly full at this instant, that the reappearance of the star will apparently occur at the bright part of her limb, situated at an angle of 282° from her vertex, at 9 h. 57 m. p.m. The moon will be in Cancer during the whole of the 8th and part of the 9th, during which day she will pass into Leo. On the 10th she will travel across Sextans, and so re-enter the eastern part of Leo on the succeeding day. During the 12th she passes into Virgo, remaining in that constellation during the whole of the 13th, 14th, and 15th. The 16th finds her in Libra, where she continues during the succeeding day. On the 18th she crosses Scorpio into the southern part of Ophiuchus, moving on the 20th through Serpens into Sagittarius, where we leave her.

"Let Knowledge grow from more to more."—ALFRED TENNYSON.

Letters to the Editor.

Only a small proportion of Letters received can possibly be inserted. Correspondents must not be offended, therefore, should their letters not appear.

All Editorial communications should be addressed to the EDITOR OF KNOWLEDGE; *all Business communications to the* PUBLISHERS, *at the Office, 74, Great Queen-street, W.C.* IF THIS IS NOT ATTENDED TO, DELAYS ARISE FOR WHICH THE EDITOR IS NOT RESPONSIBLE.

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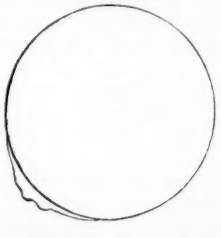
The Editor is not responsible for the opinions of corre pondents.

NO COMMUNICATIONS ARE ANSWERED BY POST, EVEN THOUGH STAMPED AND DIRECTED ENVELOPE BE ENCLOSED.

SINGULAR SOLAR PHENOMENON.

[839]—Last Sunday (May 26), while observing the sun with my 3-inch refractor, power 200, I was surprised to find that the lower left limb, as seen in the telescope, presented the following appearance:—The projecting piece was of a greenish-yellow colour, which at first led me to fancy that the effect was due to some fault in the O.G.



However, when the limb was brought into the centre of the field, no change occurred, though the remainder of the sun's edge was perfectly sharp, whether seen at the edge or centre of the field. The face was abnormally mottled, and free from spots. Sky very clear.

A friend informs me to-day that he observed the same thing with his 8¼-inch Calver. W. OWEN PROSSER, F.C.S.

STAYS AND HEALTH.

[840]—Pray do not consider me too late in offering some of my personal experience. Australia is very far for joining in discussions carried on in England; but this subject is of such moment to the

advancement of our race that I think it ought never to be deemed too late while one stays-wearer remain to be benefited by information upon it.

When about fifteen years old, the dominant powers encased me in stays. At first I cried much; then common-sense urged something more executive. Now and again I removed a bone or two, then cut a piece off, gradually lessening the size of the hated encumbrance until it was reduced to a mere belt, and finally I gave that up.

I need not tell you the inflictions those wretched instruments of torture entailed upon my young supple body, because you had the courage to try them—for which honest confession I feel so pleased with you that, in return, I confess, in my case, vanity aided good sense; for always after visiting the statuary in the British Museum, I was exceedingly discontented with the appearance of my own wooden-looking bust. That was thirty-eight years ago, and I have never once since been induced, or derided, into anything even resembling stays. Back-ache, chest-ache, headache, and indigestion in any form, are unknown to me. When you receive this I shall have entered my fifty-seventh year. Running is an enjoyment I often take, and I can jump, when necessary.

For twelve years, with the exception of a few months, I rode and drove daily, often five, six, or seven hours in the saddle. If your readers—especially the lady portion—will reflect upon the fact that it was during those years my children were born, and that they are now powerful men, healthy in mind and body, they will understand the thoroughness of the test. Were KNOWLEDGE a medical journal, I could give other proofs, almost too astounding for belief by those who have gone through very different experiences.

I have watched healthy girls gradually become weak and sickly after commencing stays-wearing. Both publicly and privately I have advocated the adoption of a more healthful mode of dress, and have satisfactory proofs of success with some, but the infatuation for displaced ribs is so strong that yet awhile the generality of women would rather listen to the sophistries of such people as your correspondent "Observer" than to the soundest reason, born of experience. Any one sincerely wishing the progress of humanity cannot look at our beautiful (in face) young girls without a feeling of pain, hobbling along in their compressing boots, squeezed waist, unpleasantly-swelled hips, and crooked shoulders. As years increase, the baleful effect of outraging nature can be sadly seen in their countenances. Long internal suffering of that sort injures the brain; hence the thousands of nothings of both sexes. For those, like myself, earnestly wishing and hoping the rise of woman—which means the rise of all human-kind—it is a most distressing cause for serious thought.

I cannot doubt your excellent articles upon it will be beneficial to all who *really* observe, think honestly, and act truthfully. You wield a great and responsible power. May you long continue to do so faithfully and fearlessly, H. A. DUGDALE.

Camberwell (Victoria), *April* 11, 1883.

RATIONAL DRESS.

[841]—Having read your various articles on dress reform, I am constrained, in gratitude, to acknowledge the benefits I have received from its adoption; and I should like, in a few words, to show how easily such reform may be effected. I need only mention that I now wear a flannel combination, and, in place of the objectionable stays, I have a loose, twilled, calico bodice, which reaches down to my hips, and is set in a band, on which is buttoned the divided skirt; over this is my ordinary dress, having the skirt and jacket-bodice attached. I was led finally to this arrangement from reflecting on the more rational character of my husband's attire; and I may add that the comfort and freedom I now enjoy from my new costume have exceeded my most sanguine expectations. L. M.

[842]—It may interest you to know that, being inspired by your article in KNOWLEDGE, I have left off wearing stays. Since I have done so I have been in better health, I have been able to walk greater distances without fatigue, and my voice for singing has greatly improved, and altogether I have derived immense comfort from the free use of all parts of my body.

I cannot resist writing to express my gratitude to you for having pointed out one of the greatest errors women are guilty of. I only hope that many of my fellow countrywomen may benefit by your advice.

I may mention that I am eighteen, and have worn corsets (owing to my height) since I was twelve. Since I have left them off I have never missed the support, and would not, on any account, wear them again. L. M. G. B.

A FEW OBSERVATIONS ON HEAT.

[843]—In a large number of heat problems we have to multiply specific heat by temperature; but, so far as I am aware, no attempt has ever been made to explain the nature of the resulting product. Nor is such explanation possible by means of physics alone; though by the aid of dynamics, it seems to be remarkably simple.

$$\begin{aligned}\text{Mass} \times \text{specific heat} \times \text{temperature} &= \text{quantity of heat}\\ &= \text{quantity of motion}\\ &= \text{momentum}\\ &= \text{mass} \times \text{velocity}\\ \therefore \text{Specific heat} \times \text{temperature} &= \text{velocity}\end{aligned}$$

Which, for simplicity, we may write—

$$ht^\circ = v$$

This result enables us to deduce the formula for specific heat from a purely dynamical theorem; for in the method by mixture, we have merely to regard the two substances as composed of imperfectly elastic particles moving with certain velocities, and impinging directly upon one another. Let us consider a single molecule, with mass A, in the one substance, and a single molecule, with mass B, in the other; and let $u\,u_1$ be the velocity of A before and after impact, and $v\,v_1$ the same with respect to B.

Then, since action and reaction are equal and opposite,

total momentum before impact = total momentum after impact

$$\text{i.e., } Au_1 + Bv_1 = Au + Bv$$

$$\therefore\ Au - Au_1 = Bv_1 - Bv$$

Representing the required specific heat of A by h and its temperature by t°, and supposing h_1 and t_1 to stand in the same capacity for B, and θ to be the temperature of the mixture, and substituting these values in the above equation, we get

$$Ah(t^\circ - \theta) = Bh_1(\theta - t^\circ)$$

$$\therefore\ h = \frac{Bh_1(\theta - t^\circ)}{A(t^\circ - \theta)},$$ which is the formula

for specific heat. If B be ice-cold water, then A impinges upon B at rest, and $v = 0$; also $h_1 = 1$, so that

$$h = \frac{B\theta}{A(t^\circ - \theta)}$$

It will also be seen that by the same theorem we can easily arrive at the general value for θ

$$\frac{Aht + Bh_1t_1 + \ldots}{Ah + Bh_1 + \ldots} = \frac{\Sigma(Aht)}{\Sigma(Ah)}$$

Many other important results may be deduced without much difficulty; but, for the present, let us confine ourselves to one in particular. Since $Aht^\circ = M$ (momentum), if M and t° be constant, $h \propto 1/A$. Does not this give us the reason why specific heat is inversely proportional to atomic weight? Such certainly seems to be the case; and moreover, this question embodies the results experimentally obtained by Regnault and others. But here at once we come to an apparent discrepancy; for only elementary solids are supposed to follow Dulong and Petit's law, whereas our equation would lead us to expect it to be universal. In the case of gases, however, I think this discrepancy will disappear when we compare them under similar conditions; and, in order to do so, we must bring to our aid another formula, mass = volume × density. The numbers obtained for solids vary, owing to experimental differences, from 5·7 to 6·9; the following table will show that those for many gases do not show a greater variation.

	Name of Gas.	Sp. heat.	At. Weight.	No. of vols.	Product of preceding cols.
Simple gases	Hydrogen	3·409	1	2	6·82
	Nitrogen	·244	14	2	6·83
	Oxygen	·217	16	2	6·96
	Chlorine	·121	35·5	2	8·59
	Bromine	·555	80	2	8·88
Gases formed without condensation	Hydrochloric acid	·185	36·5	1	6·75
	Carbon monoxide	·245	28	1	6·86
	Nitrogen dioxide	·232	30	1	6·96
Gases formed with condensation	Carbon dioxide	·217	44	⅔	6·36
	Sulphur dioxide	·155	64	⅔	6·61
	Nitrogen monoxide	·227	44	⅔	6·63
	Steam	·480	18	⅔	5.76
	Water	·504		⅔	6·05

To this list may, I think, be added alcohol, ethyl sulphide, ethyl cyanide, and many other vapours of a more complex constitution; but I have omitted them, as I am not quite certain of the exact change in volume which takes place in their formation.

It would be irrational to suppose that the closeness of these figures, not only amongst themselves, but also to those of the elementary solids, is a series of coincidences; it follows directly from the equation $Aht^\circ = M$, and may fairly be claimed as a corroboration of that equation. The case of the carbon compounds is especially noteworthy. Although their behaviour is perfectly regular, carbon itself is at ordinary temperatures a decided excep-

tion to Dulong and Petit's law. Consequently, may we not infer that there is a temperature at which carbon is not an exception? But, if our equation be universally applicable, M is a constant for all substances and at all temperatures; so that when t° is also a constant, $h \propto 1/A$, *i.e.* $h \propto 1/$ volume × density. Hence, we may, perhaps, conclude that the specific heat depends upon the mode of atomic aggregation, a conclusion that is in accordance with experiment; and, if so, we have an easy mode of ascertaining the changes in this mode, provided that we can fix the value of M approximately. Water and iodine may be mentioned as simple instances; in each case, the specific heat of the liquid is exactly twice that of the vapour. In the same way, too, we might explain the divergence of chlorine and bromine from the law; for there seems no reason why they should be treated in one way and carbon in another.

To return to the formula with which we started, $ht^\circ = v$. It may be asked what are h and t° respectively equivalent to in dynamics? It is difficult to answer the question with any certainty; but as $v = \frac{\text{space}}{\text{time}}$, and as temperature seems to correspond to space, we may regard specific heat as inversely proportional to time; a result that accords with "Method by Cooling." It must not be forgotten that v has been taken to represent the velocity, not of progression, but of vibration; but, when care is taken not to confound the two, the laws of dynamics appear to be applicable to problems connected with either. For, from the motion of two balls impinging obliquely on each other, we can deduce the laws of the refraction of heat and light; from the motion of a ball impinging obliquely upon a fixed, smooth plane, we can deduce the laws of reflection, and so on. Of course, in the case of a constant source of heat, we have uniformly accelerated motion to deal with, and different formulæ must be employed. By the aid of these it is not impossible that we shall be able, theoretically, to estimate the boiling points of different liquids; an hypothesis that I trust, before long, to be in a position to verify. HUGH COLEMAN DAVIDSON.

HOW TO USE THE EYES.

[843]—I have read the articles under this heading, by Mr. John Browning, with special interest, and for personal reasons, similar to your own, my eyes being extremely odd, instead of a pair. I think that the experience of oculists will bear me out in the assertion that perfect equality of focal length is not so common, nor disparity so rare, as is generally supposed. But although a trifling inequality of vision between the right and left eyes is a very common defect, yet I believe that my own case would be found to be unsurpassed, if even equalled, in the extreme disproportion that exists. At the present moment, the focal length (for natural vision, without effort or straining) is about 5 in. for my left eye, and 36 in. for my right eye. In my youth the focal length of my short-sighted eye was about 3 in. The other eye always has been extremely long-sighted, and so remains. As an obvious consequence, my vision is distinct but single. Dual vision, distinct or indistinct, combined or double, is beyond my personal experience or power of conception. In either case, of short or long sight, the one image is enabled, by its own clearness and distinctness, entirely to obliterate the other, which is dim and blurred; and, although I *can*, by an effort, obtain double and indistinct vision of an object at a distance of 10 or 12 inches, in practice I never do. The stereoscope and binocular are of no use to me—have no *raison d'être* in my eyes; indeed, I dispute the truth of the scientific explanation of the former; inasmuch as, with either eye singly, I can distinguish a plane from a convex or concave surface, or a solid. Similarly, spectacles are, in my view, superfluous disfigurements. No optician could make a pair to suit my vision, because the diminution for the one eye and the magnifying for the other would present two well-defined images of immensely different dimensions, which would not coincide and coalesce, whereby I should have distinct dual in lieu of as now SINGLE VISION.

[My own experience is closely akin to "Single Vision's"; but the explanation of the stereoscope is right enough.—R. P.]

WART CHARMING.

[844]—Not to occupy your valuable space with unnecessary prefatory matter on the above subject, I would merely wish to mention, in corroboration of the efficacy of the means described in your last in reference to the removal of warts on the hands, that one of my daughters was troubled for some years with these unsightly excrescences, until, happening to hear of a "charmer," in the person of a not very distant neighbour, she waived her incredulity for the time and paid the operator a visit. The *modus operandi* was precisely the same as that narrated by "Puzzled Sceptic," the warts were counted, and my daughter left. Before the end of a month every wart had disappeared. Very strange, but very true! W.

EASY MULTIPLING.

[845]—I discovered the rule for squaring numbers mentally some years ago. It does not apply to particular cases only, but is general. The formula is as follows:—

$$a^2 = (a+b)\ (a-b) + b^2$$

To take the number given by your correspondent

$35 = a$
$5 = b \therefore 35^2 = (35+5)\ (35-5) + 5^2$
$35^2 = (40)\ (30) + 25$
$35^2 = 1{,}200 + 25$
$1225 = 1225$

Take 87. Here b will equal 3—

$87^2 = (87+3)\ (87-3) + 3^2$
$87^2 = (90)\ (84) + 9 = 7560 + 9$
$7569 = 7569$

This rule I find extremely useful in practice. Most elaborately-looking squares may be done mentally in a moment. It is also of great service in multiplying feet and inches of a square form. Take the following—7 ft. 6 in. by 7 ft. 6 in.—according to the formula:—

$$\left(7'\ 6''\right)^2 = \left\{\left(7'\ 6''\right) + 6''\right\}\left\{\left(7'\ 6''\right) - 6\right\} + \left(6''\right)^2$$

The result when worked out being 56 ft. 3 in. Practically I add and deduct 6″ mentally, which gives 8 by 7 and add 3 inches, the result as above of the square of 6 inches.

Some curious mental juggling may be done in this way. Take, for example, 75. This may be thrown into the form of 7·5, which is 7 ft. 6, and this squared will give 56 ft. 3 in. The 3 in. is ·25, and substituting this for 3 in. will give a result 5625, omitting the decimal point. ROBERT MOORE.

LETTERS RECEIVED AND SHORT ANSWERS.

Æon. *Vis inertiæ* may be "a bodiless bogy," but it is quite impossible to accept conclusions based on the assumption that the first law of motion is absurd, even though you have had the news from one somewhat more fully acquainted with the laws and forces of nature than the great Newton himself.—W. B. Pray, believe that no offence being meant, none is taken. L. M. H. P. BARRY. Regret that have at present no space conveniently available.—C. E. BELL. No room for discussion of the gold question. Your solution of chance problem not quite correct.—A. K. HARTINGTON. Thanks; but no available time.—E. F. B. H. No space for description of the telescope you mention.—AMATEUR. Consult text-book on microscope.—F. CHAPMAN. No one who considers the mechanism of the foot can doubt for a moment that the fashionable boots are most injurious.—STUDENT. The fears as to probable early exhaustion of English coal rather exaggerated.—A CONSTANT SUBSCRIBER. You seem to know all about the surface of the sun. I congratulate you. You are the only man living who does. How gratifying that must be to you.—Æon (last letter). Newton *conceived* gravity as acting by a series of impulses, but he did not *imagine* that it so acted.—E. SELLON would like some information about the natural history of the parasite infesting the windpipes of chickens, and producing the disease known as "gapes."

Our Mathematical Column.

GEOMETRICAL PROBLEMS.

By RICHARD A. PROCTOR.

CONSTRUCTION—(*continued*).

SUPPOSE we had to solve such a problem as the following:—

From a given point outside the acute angle contained by two given straight lines, to draw a straight line so that the part intercepted between the two given straight lines may be equal to the part between the given point and the nearest line.

Here the natural process, in constructing the figure, would be to draw the lines, A B and B C (Fig. 2), and taking P as the given point, to draw P D E, so that P D and D E might be as nearly equal as possible. The proper way, however, is to draw a straight line, P E, bisect it in D, and through the points D E to draw the lines, A D E, C E B, meeting in B.

Again, suppose a problem spoke of a circle touching a given line in a given point, and passing through another given point. Then we should not draw a stright line, and, taking the points, P

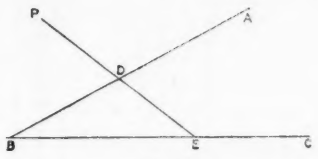


Fig. 2.

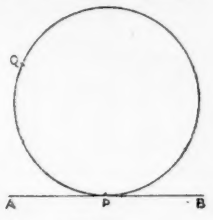


Fig. 3.

and Q (Fig. 3), attempt to draw a circle through Q to touch A B in P. We should first draw the circle, then draw a tangent, A P B, and take a convenient point, Q, upon the circumference of the circle.

In like manner if, in a deduction, mention is made of a circle inscribed within, or circumscribed without a triangle, we shall obtain a far more satisfactory figure by drawing the circle first, and then forming a triangle round it or within it, respectively, than by drawing the triangle first.

These instances suffice to exhibit the necessity of considering the order of the constructions needed in our figure. There are some considerations to be attended to, also, respecting the *shapes* to be given to different figures, that an examination of the properties they are meant to illustrate may be made as easy to us as possible.

It is very important that the different parts of a figure should not exhibit apparent relations not really involved in the problem illustrated. Lines should not seem to be equal, nor to be at right angles to each other when they are not necessarily so. Triangles should not seem to be isosceles or right-angled when the problem does not involve such relations. It is well to notice that, in general, the most convenient form of triangle for illustrating general properties is that shown in Fig. 4; here the angle A is one of about 75°, the angle B one of about 60°, and the angle C one of about 45°.

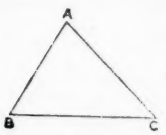


Fig. 4.

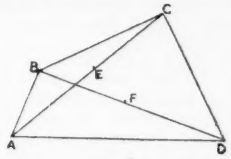


Fig. 5.

When a quadrilateral figure is not necessarily either a parallelogram or a trapesium, it is well to construct it of such a figure as A B C D (Fig. 5), in which the four sides are unequal, neither pair of opposite sides parallel, and the diagonals A C, B D do not make equal angles with any side. It will be noticed, also, that neither diagonal bisects the other. If we had a problem in which the bisections E and F of the diagonals were concerned, all that would be necessary, in order that neither diagonal might bisect the other, would be to draw the diagonals A C and B D *first*, so that their point of intersection, G, should be well removed from the bisections, E and F; then join A B, B C, C D, and D A.

It is sometimes convenient to draw a part of the figure in darker lines than the rest. We may distinguish in this way, for instance, between the lines or circles belonging to the enunciation and those belonging to the construction. When we are in doubt as to the necessity of any construction, it may be lightly dotted in. In very complex figures, dark, light, broken, and dotted lines may be conveniently employed together.

Always letter every point of the figure which may have to be referred to as you proceed. It is often as well, when a result has been established which seems to promise to be useful towards the solution of a problem, to re-draw the figure, omitting all lines except those which have served to guide you to this result. But, except in such instances, or where the figure seems obviously unsuited to your requirements, or has become overcrowded with constructions, it is well to keep to the same figure as long as possible. The habit of repeatedly re-drawing figures interferes with the concentration of the attention, and the steady progress from result to result, which alone avail toward the solution of difficult problems.

(To be continued.)

Our Chess Column.

By MEPHISTO.

PLAYED IN THE SECOND ROUND ON JUNE 1ST.

IRREGULAR OPENING.

White. Zukertort.	Black. Mason.
1. Kt to KB3	P to Q4
2. P to Q4	Kt to KB3
3. P to K3	B to Kt5 (*a*)
4. B to K2	B takes Kt
5. B takes B	P to K3
6. Castles	B to Q3
7. P to B4	P to B3
8. Kt to B3	QKt to Q2 (*b*)
9. P to QKt3	R to QB sq.
10. B to Q2	B to Kt sq. (*c*)
11. R to K sq. (*d*)	P to KR4
12. P takes P	BP takes P
13. P to K4	P takes P
14. Kt takes P	Kt takes Kt
15. B takes Kt	Kt to B3
16. B takes P	B takes P (ch.)
17. K to B sq.	R to QKt sq.
18. Q to B3	B to Q3
19. B to Kt5	B to K2 (*e*)
20. QR to Q sq. (*f*)	Castles

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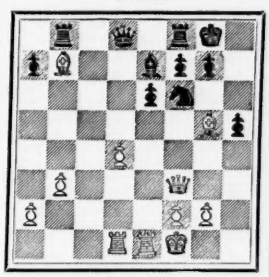

WHITE.

21. B takes Kt	B takes B
22. B to K4	P to Kt3
23. P to Q5	P takes P
24. R takes P	Q to Kt3
25. Q to Kt3 (*g*)	B to Kt2
26. R to Q6	Q to B4
27. KR to Q sq.	QR to K sq. (*h*)
28. B to Q5	Q to B7
29. B to B4	K to R2

White. Zukertort.	Black. Mason.
30. R (Q6) to Q2	Q to B4
31. Q to B7	B to B6
32. R to Q3 (*i*)	B to Kt2
33. R to Q5	Q to B3 (*j*)
34. Q takes RP (*k*)	QR to R sq.
35. Q to B5	R takes P
36. P to QKt4	R to B7 (*l*)
37. R takes P (ch.)	K to Kt sq. (*m*)
38. R to R3	R to B6
39. R takes R	Q takes R
40. P to Kt5	B to B3

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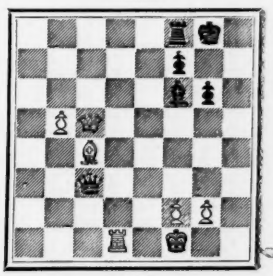


WHITE.

41. P to Kt6	K to Kt2
42. P to Kt7	R to KR sq.
43. K to Kt sq.	B to K4
44. Q to Q5	B to R7 (ch.)
45. K to B sq.	Q to B3
46. QtksP(ch.) (*n*)	Q takes Q
47. B takes Q	K takes B (*o*)
48. P to Kt3	B takes P
49. P takes B	K to K3
50. K to Kt2	R to QKt sq.
51. R to QKt sq.	K to B4
52. K to B3	K to Kt4
53. R to Kt5 (ch.)	K to B3
54. K to Kt4	K to Kt2
55. K to Kt5	K to R2
56. R to Kt6	K to Kt2
57. R takes P(ch.)	K to B2
58. R to QKt6	Resigns.

NOTES.

(*a*) Which must lead to the exchange of the Bishop against the Knight, thus leaving the opponent with two Bishops at a very early stage of the game. On the other hand, it must be admitted that the second player obtains thereby some attack.

(*b*) If 8 . . . . P takes P, White recovers the Pawn with 9. Q to K2, for Black dare not reply P to QKt4, on account of 10. Kt takes P.

(*c*) Making everything ship-shape for an immediate attack against the adverse King's quarters.

(*d*) For both offensive and defensive purposes, for White threatens now to force the opening of the King's file, and he clears a retreat for his King.

(*e*) Tempting, but disastrous would be 19 . . . . Kt to Kt5, 20. R takes P (ch.), K to B sq. (best), 21. B takes Q., Kt to R7 (ch.), 22. K to K2, Kt takes Q, 23. R takes B, and White remains with a piece ahead.

(*f*) 20. B to B4, B to Q3, 21. QB6 (ch.), K to K2 would be in Black's favour.

(*g*) Threatening, R to Q6, or R takes P.

(*h*) If 27 . . . . B to K4, White wins with 28. R takes P (ch.), P takes R, 29. Q takes P (ch.), B to Kt2, 30. B to Q5 (ch.), and Black must sacrifice his Queen, for if 30 . . . . K to R sq., White would mate in two moves.

(*i*) White conducts the attack with much vigour up to this

point, but here he misses the strongest continuation, viz., 32. R to Q7.

(*j*) Well played; he threatens R to K2 and Q to R5 at the same time.

(*k*) After 34. R to Q7, Q to R5, 35. K to Kt sq., B to K4, 36. R takes P (ch.), K to R3, 37. R to R7 (ch.), K to Kt4, White's game would be hopelessly compromised.

(*l*) A miscalculation, as Mr. Mason informed us.

(*m*) Of course if 37 . . . . P takes R, then 38. B to Q3 (ch.), and 39. B takes R.

(*n*) A very pretty coup, which either disposes of the Bishops of different colour or wins a Pawn.

(*o*) If 47 . . . . B to Knight sq., then 48. R to Q7, and White must ultimately win.—*Standard.*

PLAYED IN THE SECOND ROUND, JUNE 2ND, 1883.

EVANS GAMBIT.

White. Tschigorin.	Black. Steinitz.	White. Tschigorin.	Black. Steinitz.
1. P to K4	P to K4	21. P to B4	P takes P en p
2. Kt to KB3	Kt to QB3	22. Kt takes P	Kt to K2
3. B to B4	B to B4	23. P to K5	BP takes P
4. P to QKt4	B takes P	24. P takes P	P to Q4
5. P to B3	B to B4	25. R to KB sq	Kt to B4
6. Castles	P to Q3	26. Kt to Q4	Q to Kt3
7. P to Q4	P takes P	27. Kt takes Kt	B takes Kt
8. P takes P	B to Kt3	28. B to R4 (*h*)	P to QB4
9. Kt to B3	Kt to R4 (*a*)	29. R to KB3	K to Q2 (*i*)
10. B to KKt5 (*b*)	P to KB3	30. QR to KB sq.	KR to B sq
11. B to B4 (*c*)	Kt takes B	31. R to KKt3	Q to R3
12. Q to R4 (ch.)	Q to Q2	32. B to B6	B to K3
13. Q takes Kt	Q to B2 (*d*)	33. Q to R7 (*j*)	K to B2
14. Kt to Q5 (*e*)	P to Kt4	34. R to QKt 3	K to Q2
15. B to Kt3	B to K3	35. Q takes P at Kt 3	R to B3
16. Q to R4 (ch.)	B to Q2	36. Q takes P (ch.)	R to B2
17. Q to R3 (*f*)	R to B sq.	37. Q to Kt5 (ch.)	R to B3
18. KR to K sq.	P to Kt5	38. Q to Kt7 (ch.)	R to B2
19. Kt takes B	RP takes Kt	39. Q to R 6	Resigns (*k*)
20. Kt to Q2	B to K3 (*g*)		

NOTES.

(*a*) Or B to Kt5, which leads to a satisfactory game.

(*b*) Looks like loss of time.

(*c*) Evidently stronger than B to R4—the move given by the Handbook.

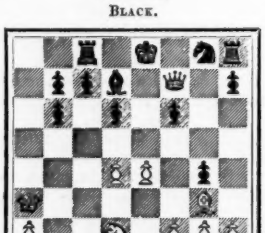
(*d*) Recommended by the book, but we are of opinion that P to B3 is worthy of closer examination.

(*e*) A good move; it prevents Black from playing Kt to K2, and threatens to break up the Pawns on the Q side.

(*f*) White now threatens, Kt takes B, and to win a Pawn.

(*g*) This appears unsatisfactory; but Black had no really satisfactory move. If he play Kt to K2, the following would be a tempting continuation for White:—21. P to K5, BP takes P. 22. P takes P, P to Q4. 23. P to K6, B takes P. 24. Q to K3, K to Q2, with a defensive position. If White does not push the KP, Black may venture on Castling. On the whole, we should have preferred it to the move in the text. We give a diagram of the position after White's 20th move, Kt to Q2:—

STEINITZ.
BLACK.



WHITE.
TSCHIGORIN.

(*h*) White played the ending with great accuracy and strength.

(*i*) B to KB sq. would not have answered well, as White would double the Rooks, and then Q to R4 (ch.) would be troublesome, as neither Q nor B could interpose.

(*j*) This is very fine and telling play.

(*k*) Black has no resource. White threatens Q to Q6 (ch.). If Black plays: 39. R to K sq. 40. Q to Q6 (ch.), K to B sq. 41 KR to Kt sq. and wins.

THE TOURNAMENT.
SCORE UP TO TUESDAY NIGHT.

	Bird	Blackburne	English	Mackenzie	Mason	Mortimer	Noa	Rosenthal	Sellman	Skipworth	Steinitz	Tschigorin	Winawer	Zukertort	Draws not counting	Total score
Bird	—	1	1	0	1	0	1	0	1	1	1	0	0	1	6	9
Blackburne	0	—	1	0	1	1	1	1	1	1	1	0	½	1	0	10	12½
English	0	0	—	½	0	0	1	1		1	1	1	0	0	0	13	9½
Mackenzie	0	1	½	—	0	1	1	0	½	1	1	0	0	0	0	12	9
Mason	1	0	0	1	—	1	½	1	0	1	1	0	1	0	0	10	11½
Mortimer	0	0	0	0	0	—	0	0	0	0	0	1	0	0	0	4	1
Noa	1	0	0	0	½	1	—	1	0	0	1	0	0	1	0	5	6½
Rosenthal	1	0		1	0	1	1	—	0	1	1	1	½	0	0	14	10½
Sellman	0	0	0	½	0	0	1	1	—	0	1	0	0	0	0	7	5½
*Skipworth	0	0	0	0	0	0	1	0	1	—	0	0	0	0	0	2	3
Steinitz	1	1	0	0	1	0	0	1	0	1	—	0	1	1	0	3	12
Tschigorin	1	1	0	1	0	1	1	0	1	1	1	—	1	0	0	4	11
Winawer	0	½	1	1	0	1	1	½	1	1	1	0	—	0	0	14	10
Zukertort	1	1	1	1	1	1	1	1	1	1	1	1	1	—	0	17	

* Retired.

Wednesday, May 30th.—Four draws were played off. Steinitz drew again with English (second draw), as did also Rosenthal and Winawer. Blackburne again had a well-deserved victory over Mason, whom it will be recollected he also vanquished in the first round. Mackenzie beat Sellman.

Thursday, May 31st.—Blackburne was victorious against the Russian champion, Tschigorin, while Mason again suffered defeat at the hands of Winawer. Zukertort could only draw with Mackenzie; English drew against Rosenthal; Noa beat Mortimer, and Bird beat Sellman.

Friday, June 1st.—Zukertort again distinguished himself by winning the fine game against Mason, given on previous page. Another sensational event was the defeat of Steinitz by Tschigorin. Further results were:—Blackburne and Winawer, Noa and Mackenzie, drew; Rosenthal beat Mortimer; Englisch beat Sellman. Skipworth having retired from the contest, all his opponents count 1 without playing.

Saturday, June 2nd.—Three draws were played off. Blackburne again drew with Winawer. Mackenzie beat Noa. The only game outstanding from the first round, between Rosenthal and English, again, and for the second time, was drawn.

Monday, June 4th.—Mackenzie beat Blackburne; Rosenthal beat Mason; English beat Bird; Winawer could only draw with Sellman; and Zukertort also received a temporary check by Tschigorin obtaining a draw. Mortimer, after a hard-fought game, likewise drew with Steinitz.

Tuesday, June 5th.—Zukertort defeated Noa; Blackburne beat Mortimer; Steinitz was victorious against Winawer; and Mason against English. The games between Sellman and Tschigorin, Mackenzie and Bird, resulted in draws.

In the second Tournament, Bardeleben takes first prize with a score of 21½; Fisher, second, 20½; MacDonnell, third, 19½. The other prizes are not fixed yet.

NOTICES.

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